

Polarimetric Radar Remote Sensing of Ocean Surface Wind

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An innovative radar concept for ocean wind vector measurements is described in this paper. This new concept, based on the polarimetric radar technology, has a strong potential for improving the wind velocity measurement accuracy under rainy conditions and extending the useful swath width by up to 40 percent for follow-on spaceborne scatterometers to NASA SeaWinds missions.

The key issue is whether there is a relationship between the polarization state of ocean backscatter and ocean wind velocity at NASA scatterometer frequencies (13 GHz). It was noted by the theoretical predictions that the correlation between the co- (S_{VV} and S_{HH}) and cross-polarized (S_{VH} and S_{HV}) radar backscatter from sea surfaces has an odd-symmetry with respect to the wind direction, unlike the symmetry property of normalized radar cross section, σ_0 s. If this is true, the correlation between co- and cross-polarized channels will provide additional information regarding the direction of sea surface wind, and may enable significant enhancement to the SeaWinds-like conical scanning scatterometers. However, no radar observations were available to support this prediction.

We developed an airborne Ku-band (13.95 GHz) polarimetric scatterometer (POLSCAT) to acquire experimental evidence for the suggested polarization signature. POLSCAT was installed together with the JPL Passive/Active L-/S-band (PALS) microwave instrument designed for ocean salinity sensing on the National Center for Atmospheric Research (NCAR) C-130 aircraft. A set of flights was performed over the buoys deployed by the Monterey Bay Aquarium Research Institute (MBARI) off the California coast in August 2000. On August 16, the buoy wind was 10 m/s from the northwest over the MBARI M2 buoy. The data are examined against the relative azimuth angle between the wind and antenna look directions. VV and HH σ_0 s are symmetric with respect to the wind direction, consistent with the SeaWinds radar observations. VH and HV σ_0 s of ocean surfaces, not yet reported in the literature, are also symmetric with respect to the wind direction. The other polarimetric radar measurements are the normalized correlation ($\rho_{\alpha\beta\gamma\delta}$) between $S_{\alpha\beta}$ and $S_{\gamma\delta}$ polarization. It was observed that the correlation between VV and HH , ρ_{VVHH} , is symmetric with respect to the wind direction, while the correlation between co- and cross-polarized channels is anti-symmetric. This confirms the theoretical predictions that there are even and odd symmetry properties in the polarimetric radar signals of sea surfaces. The flight conducted on August 17 yielded similar characteristics. The proof-of-concept experiment was successful and provided evidence supporting the polarimetric scatterometer concept for ocean wind measurements.